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Williams, Jr.

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[54] **APPARATUS AND METHOD FOR CLEANING EXCHANGER TUBES**

[76] Inventor: **Robert V. Williams, Jr.**, 16 Bay Harbor, La Porte, Tex. 77571

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[52] **U.S. Cl.** ..... **134/7**; 134/24; 134/167 C; 134/8; 134/22.12; 165/95

[58] **Field of Search** ..... 165/95; 134/22.12, 134/24, 167 C, 171, 166 C, 7

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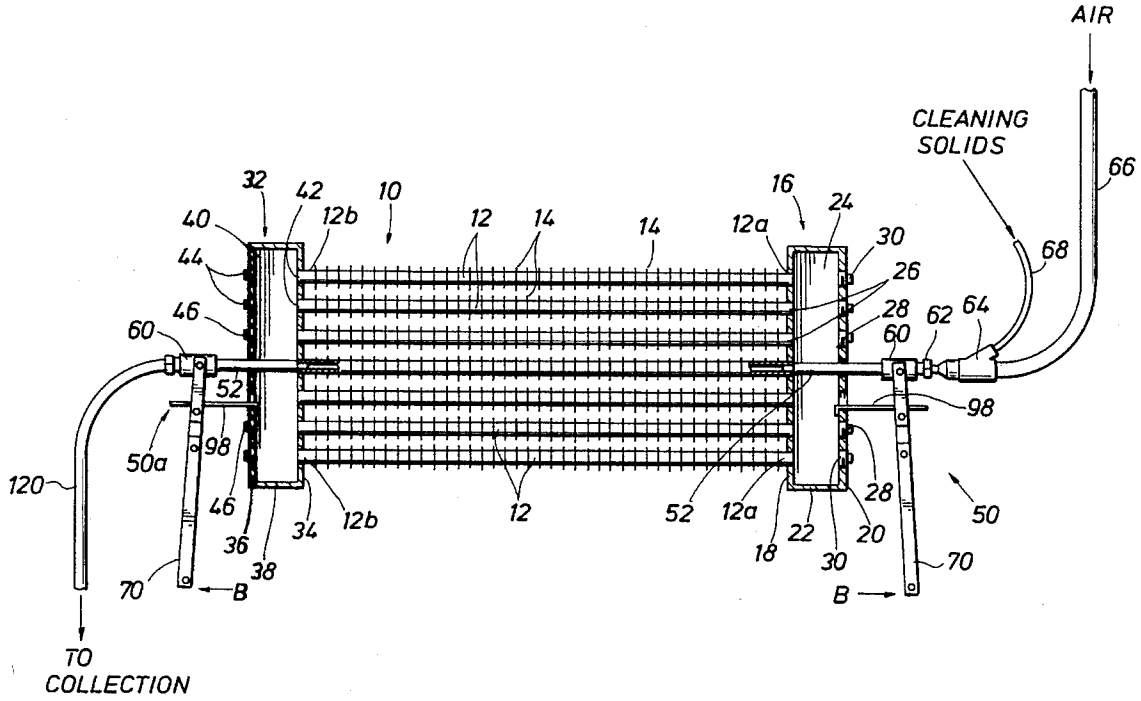
Primary Examiner—Allen J. Flanigan

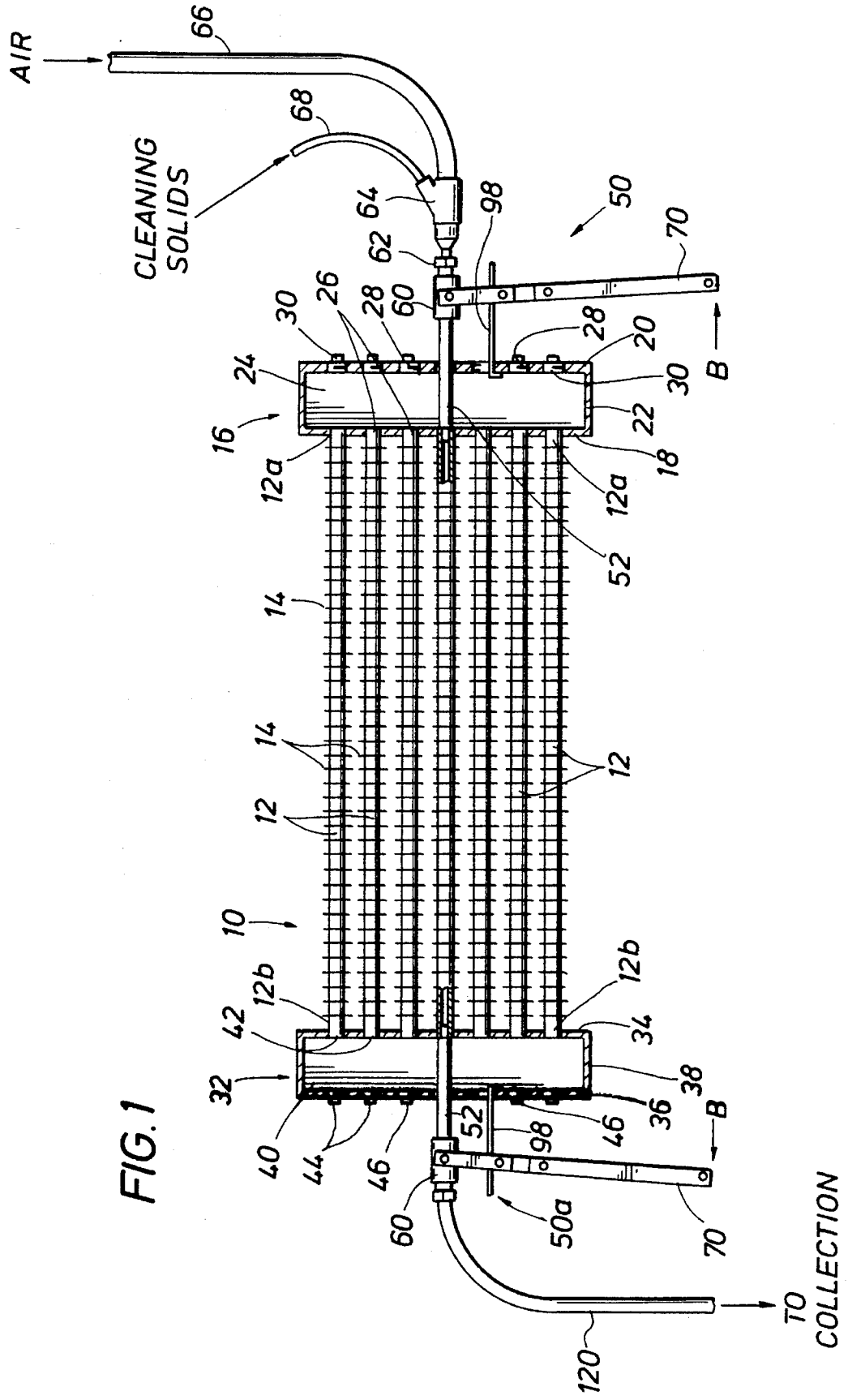
Attorney, Agent, or Firm—Browning, Bushman, Anderson & Brookhart

[57] **ABSTRACT**

An apparatus and method for cleaning the tubes of a heat exchanger of a type having at least one header that defines a manifold chamber having a plurality of tubes extending therefrom, the tubes and the header defining tube openings to provide open communication between the tubes and the manifold chamber, the tube openings defining a peripheral seating surface, there being bores in the header, respective ones of which are in register with respective ones of the tube openings, the apparatus comprising a tubular member having a first end and a second end, the tubular member being dimensioned such that the first end can be received through at least one of the bores, a force transmitting lever assembly connected to the tubular member and operatively connected to the header whereby the tubular member can be urged toward the seating surface of a tube opening in register with a bore through which the tubular member is received, there being a seal formed between the tubular member and the seating surface.

17 Claims, 2 Drawing Sheets




AIR
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CLEANING SOLIDS
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TO COLLECTION
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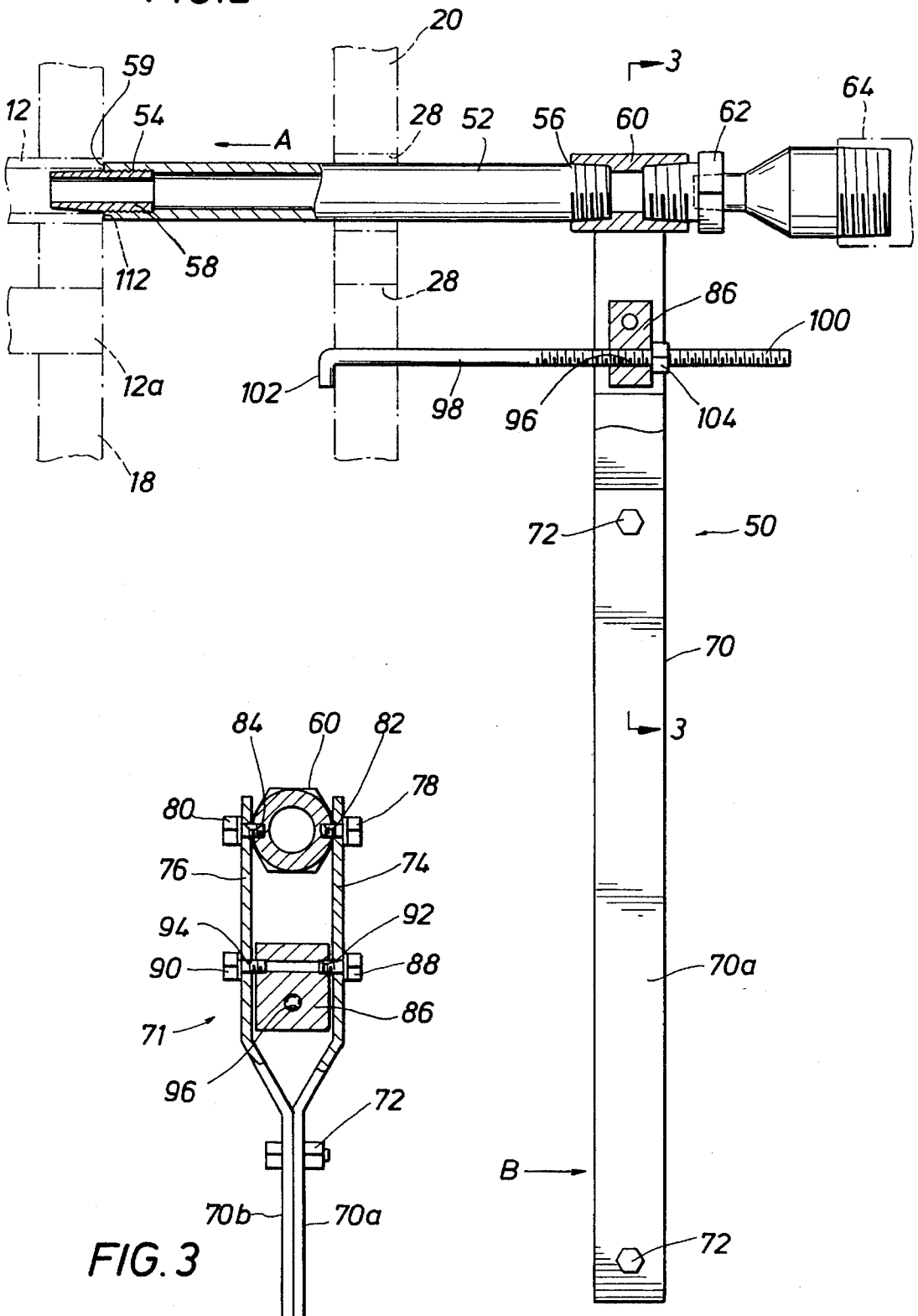
FIG. 1

FIG. 2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72
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84
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72
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70b
70a
72

FIG. 3

APPARATUS AND METHOD FOR CLEANING EXCHANGER TUBES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus and method for cleaning the interior of tubular bodies such as heat exchanger tubes and, more particularly, to an apparatus and method for cleaning finned (air cooled) heat exchanger tubes.

2. Description of the Prior Art

Air-cooled heat exchangers are used in many applications in the chemical and refining industry and are particularly used in areas of water scarcity. These air-cooled heat exchangers are comprised of externally finned tubes generally disposed horizontally between spaced headers that define manifold chambers whereby a fluid to be cooled can be introduced into one header, pass through the finned tubes to be cooled, and exit through the opposite header. Although the finned tubes are generally cooled by means of fans to enhance their efficiency, finned heat exchangers are generally mounted at elevated locations to take advantage of greater air movement and air that is generally cooler.

As do all heat exchangers, air-cooled, finned exchangers require periodic cleaning of the tubes to remove scale and other deposits that build up on the interior of the tubes and reduce the heat exchange efficiency of the tubes. To date, this has been a time-consuming and often dangerous operation. For one, as noted above, the finned heat exchangers are generally mounted at elevated locations and sometimes require temporary scaffolding to be built so that the tubes can be accessed for cleaning. The prior art cleaning process is labor-intensive and time-consuming. Finned exchangers are generally constructed such that the finned tubes cooperate with the headers to form tube openings, thereby providing open communication between the manifold chambers formed by the headers and the interior of the tubes. In order to access the tubes for cleaning, removable, threaded plugs are received in bores in the header, such bores being in register with the tube openings. Thus, in a typical prior art cleaning method, a removable plug would be removed from the bore on one header and a corresponding plug removed on the opposite header such that a cleaning wand could be inserted through one of the headers into the tube and run up and down the length of the tube to clean the scale, deposits, etc., from the interior surface of the tube. With the plug removed from the opposite header, the cleaning medium and the dislodged scale and other debris can be removed from the tube being cleaned and collected in a suitable fashion. The tubes are typically cleaned with a pressurized air/solids cleaning medium, and it is important that none of the debris and/or solid cleaning medium be deposited in either of the headers lest this cause plugging or contamination when the exchanger is put back into operation.

Accordingly, in the past, the threaded plug would be removed, bored out, and fitted with a nozzle so that the plug/nozzle assembly could be screwed back into the bore until the nozzle effected a metal-to-metal seal with the tube opening. The source of abrasive would then be attached to the plug containing the nozzle to introduce the cleaning medium into the tube being cleaned. On the opposite end of the tube being cleaned, a spanner tube would be attached to a similarly bored-out plug so that the exiting cleaning medium and/or debris could be expelled from the tube without being deposited in the opposite header.

It will readily be apparent that such an operation is extremely time-consuming and, because of the fact that workers conducting the cleaning may be on temporary scaffolding at considerable height, also quite dangerous.

It would therefore be desirable to have an apparatus for cleaning heat exchanger tubes that can be quickly and easily mounted to the exchanger and will minimize the chances of any solid cleaning medium or debris being deposited in the headers of the exchanger. It would also be desirable to collect and contain the debris and cleaning medium in order to prevent environmental contamination and aid in packaging for disposal.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an improved apparatus for cleaning the tubes of a heat exchanger.

Yet another object of the present invention is to provide an apparatus for cleaning air-cooled heat exchangers of the finned tube type.

Still a further object of the present invention is to provide an apparatus for cleaning the tubes of a heat exchanger that ensures that the cleaning medium and debris dislodged thereby does not collect in the headers of the exchanger.

Still a further object of the present invention is to provide a method of cleaning the tubes of a heat exchanger that is faster and safer than prior art conventional methods and that minimizes or eliminates the deposition of solid cleaning media, such as abrasives, as well as debris, in the headers of the exchanger.

It is another object of the present invention to provide an apparatus for cleaning the tubes of a heat exchanger that permits conveying debris from the exchanger tube and the cleaning medium to suitable collection vessels.

The above and other objects of the present invention will become apparent from the drawings, the description given herein, and the appended claims.

In one embodiment, the present invention provides an apparatus for cleaning the tubes of a heat exchanger of a type having at least one header, and usually two spaced headers interconnected by a series of exchanger tubes. A typical header has first and second, spaced walls defining a manifold chamber therebetween. A plurality of tubes extend from the first wall and have ends that cooperate with the first wall to define tube openings providing open communication between the interior of the tubes and the manifold chamber. Each of the tube openings defines a peripheral seating surface. The second wall of the header is provided with a plurality of bores, respective ones of which are in register with respective ones of the tube openings in the first wall. The apparatus of the present invention for use in cleaning the tubes of such exchangers comprises a tubular member having a first end and a second end and being dimensioned such that the first end of the tubular member can be received through at least one of the bores in the second wall of the header. In a preferred embodiment, guide means are carried by the tubular member such that the tubular member can be brought into register with a tube opening, which is in register with the bore through which the tubular member is received. There are means to effect a substantial seal between the tubular member and the seating surface and force transmitting means connected to the tubular member, said force

transmitting means defining a pivot point and being operatively and selectively connectable to the second wall of the header whereby a force exerted on the force transmitting means and acting around said pivot point urges the tubular member toward the first wall. The apparatus can further include a means for supplying a fluidized cleaning medium through the tubular member into the tube or a means for conveying fluidized cleaning medium and/or debris from the tube to a point external of the header.

In another embodiment of the present invention, there is provided a method of cleaning the tubes of the heat exchanger of the type described above wherein a first tubular member is inserted through one of the bores and brought into register with one of the tube openings, which is in register with the bore through which the tubular member is received. The tubular member is releasably connected to one header to establish a first pivot point whereby a force exerted around said first pivot point urges the first tubular member toward the first and second walls of the one header to thereby effect a substantial seal between the first tubular member and the seating surface. A fluidized cleaning medium, e.g., air/particulate abrasive, is introduced through the first tubular member and into the tube.

In a preferred embodiment of the cleaning method, a second tubular member is inserted through one of the bores in the second wall of the opposite header and brought into register with one of the tube openings, which is in register with the bore through which the second tubular member is received and the tube opening in the first header with which the first tubular member is in register. The second tubular member is releasably connected to the second header to establish a second pivot point such that a force exerted around said second pivot point urges the second tubular member toward the first and second walls of the second header and effects a substantial seal between the second tubular member and the seating surface of the tube opening in the second header. The fluidized cleaning medium passing through the tube being cleaned is transported through the second tubular member out of the tube so as to prevent the cleaning medium from being deposited in the manifold chamber of the second header.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevational view, partly in section, of a typical finned heat exchanger showing the apparatus of the present invention being used to clean the tubes thereof.

FIG. **2** is an elevational view, partly in section, of the cleaning apparatus of the present invention.

FIG. **3** is a view taken along the lines **3**—**3** of FIG. **2**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although the invention will be described with particular reference to the cleaning of heat exchanger tubes of the air-cooled or finned type, it is understood that the invention is not so limited. The cleaning apparatus of the present invention can be used in any tube cleaning application wherein the tubes are connected to a header in a manner similar to that found in a typical finned heat exchanger as hereinafter described.

With reference first to FIG. **1**, there is shown a typical finned heat exchanger, shown generally as **10**, comprised of a plurality of tubes **12** that define a tube bundle, each of the tubes being provided with a series of fins **14** that enhance heat transfer between the medium inside the tubes **12** and air forced across the tubes **12**. Although not necessary, the tubes **12** are generally horizontally disposed and, conventionally, collectively form what is referred to as a tube bundle. The tubes **12** have a first end **12***a* and a second end **12***b*. Each of the first ends **12***a* of the tubes **12** is connected to a first header, shown generally as **16**, comprised of a first wall **18** and a spaced, second wall **20** that cooperate with a side wall **22** to form a manifold chamber **24** between first and second walls **18** and **20**, manifold chamber **24** being provided with an inlet (not shown) to introduce the fluid to be cooled. First ends **12***a* of tubes **12** cooperate in a well-known manner with first wall **18** to define a first set of tube openings **26** providing open communication between tubes **12** and manifold **24**. Second wall **20** of header **16** is provided with a series of threaded bores **28** in which are received threaded plugs **30**. Bores **28** in second wall **20** are in register with tube openings **26** in first wall **18**.

In like fashion, the second ends **12***b* of tubes **12** are connected to a second header, shown generally as **32**, second header **32** having a first wall **34**, a spaced second wall **36**, and a side wall **38** that cooperate to form a second manifold chamber **40**. Although not shown, chamber **40** is provided with an outlet for the removal of cooled fluid passing from chamber **24**. First ends **12***b* of tubes **12** cooperate with first wall **34** of second header **32** to form a second set of tube openings **42**, which provide open communication between manifold chamber **40** and the interior of tubes **12**. Second header **32** is also provided with a plurality of threaded bores **44** in second wall **36**, each of which is in register with a respective one of the tube openings **42** and is plugged with a threaded plug **46**. In effect, it will be seen that if one of the plugs **30** is removed from a bore **28** in first header **16** and a corresponding plug **46** is removed from a bore **44** in second header **32**, an uninterrupted flow path will be formed from the exterior of first header **16** through one of the tubes **12** and through second header **32**; i.e., a continuous open bore will appear through the exchanger **10**.

As can be seen in FIG. **1**, exchanger **10** is equipped with the apparatus of the present invention for the purpose of the tubes **12** being cleaned. To more fully understand the construction and operation of the cleaning apparatus of the present invention, reference is now made to FIGS. **1**–**3**. As shown in FIG. **1**, there is an apparatus, shown generally as **50**, attached to first header **16** for introducing a cleaning medium into the tubes **12** to clean the tubes **12** and a second apparatus **50***a* attached to second header **32** for allowing the cleaning medium and debris to be expelled from the tubes **12** and collected externally of exchanger **10**, i.e., without collecting in second header **32**. Apparatuses **50** and **50***a* are alike in all respects with the exception, as seen more fully hereafter, that cleaning apparatus **50** is attached to a means for supplying the fluidized cleaning medium while apparatus **50***a* is attached to a collection conduit to direct the cleaning medium and debris to a suitable collection station externally of exchanger **10**. Accordingly, only apparatus **50** will be described in detail, it being understood that apparatus **50***a* is of like construction, with the exception noted above.

Apparatus **50** is comprised of a tubular member **52** (formed of one or more pieces), having a first end **54** and a second end **56**. A nozzle **58** is threadedly received to the threaded I.D. of first end **54** of tubular member **52**, an annular shoulder **59** thereby being formed on first end **54**. Second end **56** of tubular member **52** is externally threaded and is received in the first end of a collar **60**. Collar **60** forms a coupling between tubular member **52** and a fitting **62**, which in turn is attached, in a well-known manner, to a manifold **64** (see FIG. **1**) into which is introduced a pres-

surized cleaning medium as, for example, in this case pressurized air or some other pressurized gaseous medium via line **66** from a source (not shown) and a particulate solid—e.g., abrasive—through line **68** from a suitable source, e.g., a pressurized pot (not shown). It will be understood that it is not necessary to introduce a source of pressurized gas, e.g., from line **66**, and a pressurized particulate solid, e.g., from line **68**, through separate lines. Frequently, the gas (air) carrying the solid (abrasive) cleaning medium from the pressurized pot is sufficient to maintain suitable velocities on the solid cleaning medium. Accordingly, manifold **64** could be dispensed with; i.e., a single line feeding a pressurized, particulate solid could be attached to tubular member **52**.

Apparatus **50** is provided with a lever **70**, which is best seen in FIG. **3** as comprised of two members **70***a* and **70***b*, bolted together with bolts **72**, members **70***a* and **70***b* being formed into a yoke shown generally as **71**, formed at one end of lever **70** and having spaced-apart tines **74** and **76**. Tines **74** and **76** are pivotally connected to collar **60** by means of bolts **78** and **80**, which are received through holes in tines **74** and **76**, respectively, and threadedly received into bores **82** and **84**, respectively, on opposite sides of collar **60**.

Disposed between tines **74** and **76** is a mounting block **86**, mounting block **86** being pivotally secured to yoke **71** by means of bolts **88** and **90**, received through registering holes in fines **74** and **76**, respectively, bolts **88** and **90** being threadedly received in threaded, registering bores **92** and **94**, respectively, in mounting block **86**. Accordingly, mounting block **86** is pivotally mounted to lever **70**. As seen hereafter, a pivot point is established defined by the locus of the interconnection of mounting block **86**, arm member **98**, and lever **70**. Mounting block **86** is also provided with a threaded bore **96**. An arm member **98**, having a threaded end **100**, is threadedly received in bore **96**. The other end of arm member **98** has a laterally extending finger **102**. It can thus be seen that arm member **98** can be adjusted such that the distance of finger **102** from lever **70** can be lengthened or shortened. A locking nut **104** is used to secure arm member **98** at the desired location.

The operation of the cleaning apparatus of the present invention will now be described. Tubular member **52**—which although shown as one piece, could be made of several pieces—is dimensioned so as to be received through bore **28** of wall **20**, it being understood that plug **30** has been removed. As can be seen with reference to FIG. **2**, bore **28** has a larger I.D. than tube opening **12***a*. Thus, while tubular member **52** can be received through bore **28**, as shown, the O.D. of tube **52** is too large to be received into tube opening **12***a*. However, nozzle **58** is of a smaller O.D. than the I.D. of tube opening **12***a*, and accordingly, nozzle **58** can be inserted into the opening **12***a* in register with the bore **28** through which tubular member **52** is received. In effect, nozzle **58** performs the function of acting as a guide to assist in bringing tubular member **52** into register with tube opening **12***a*. By forcing tubular member **52** in the direction of arrow A, it will be seen that annular shoulder **59** will be forced against a peripheral seating surface **112** in surrounding relationship to tube opening **12***a* and forming a generally planar annular surface. In effect, with shoulder **59** urged against seating surface **112**, a metal-to-metal seal is achieved between tubular member **52** and tube opening **12***a*.

To facilitate sealing engagement between shoulder **59** and seating surface **112**, arm member **98** is positioned through an adjacent bore **28** in first wall **20** such that finger **102** hooks on the inside surface of wall **20**. In this regard, it will be observed that the distance of finger **102** from mounting member **86** is adjusted such that when annular shoulder **59** is in engagement with seating surface **112**, lever **70** is substantially parallel to second wall **20**. It will now be observed that if a force is exerted, e.g., by a worker, against lever **70** in the direction shown by arrow B, lever **70** will pivot around the pivot point determined by the interconnection or locus of arm member **98**, mounting block **86**, and lever **70**. Since arm member **98** is hooked to wall **20**, tubular member **52** will be forced in the direction shown by arrow A such that shoulder **59** will be urged against seating surface **112**. At this point, there will be an effective metal-to-metal seal between tubular member **52** and tube opening **12***a* such that a cleaning medium such as a fluidized air/abrasive mixture can now be introduced through mixing manifold **64**, collar **60**, tubular member **52**, and into tube **12** to dislodge scale and other deposits from the inside surface of tube **12**. It will be understood that since the cleaning medium is under pressure and will be propelled through tube **12** from header **16** toward header **32**. While it is conceivable that header **32** could be of a type wherein wall **36** is completely removable such that the cleaning medium and any debris would simply be discharged and not be left in header **2**, most commonly, header **32** is of the same configuration as header **16**, meaning that the cleaning medium and any dislodged debris will collect in header **32** unless conveyed out of tube **12** and externally of header **32**. Using the apparatus of the present invention, this can be easily accomplished.

With reference again to FIG. **1**, it can be seen that with apparatus **50** in place on first header **16** and apparatus **50***a* in place on second header **32**, tubes **52** of apparatuses **50** and **50***a* will be in register with one another; i.e., they will both be engaged in the same tube **12**. The cleaning medium comprised of air via line **66** and the solids via line **68** are now introduced through mixing manifold **64** and tubular member **52** and into tube **12**, described above, a force being exerted against lever **70** in the direction of arrow B to form the metal-to-metal seal described above. At the same time, with tubular member **52** of apparatus **50***a* in place as shown—i.e., tubular member **52** of apparatus **50***a* is in register with tubular member **52** of apparatus **50**—and again with a force being applied against lever **70** of apparatus **50***a* in the direction of arrow B, there will be a metal-to-metal seal between tubular member **52** of apparatus **50***a* and tube opening **42**, which is in register with tube opening **26**, in which tubular member **52** of apparatus **50** is received. Accordingly, the cleaning medium and any debris removed from the tube **12** being cleaned will be conveyed through tubular member **52** of apparatus **50***a* and sent to an external collection device via collection tube **120**, connected to collar **60** of apparatus **50***a*. Essentially, then, no cleaning media or debris will be deposited in either of manifold chambers **24** or **40** or discharged to the environment.

In conducting the method of the present invention, one worker will operate apparatus **50** while the other worker will operate apparatus **50***a*. Once all of the threaded plugs **28** and **46** are removed, the workers can move in a systematic fashion from tube to tube simply by connecting arm **98** to a bore adjacent a bore through which the tubular members **52** are received. Apparatuses **50** and **50***a* are both quick connect and disconnect in the sense that the arms **98** can be quickly and easily releasably locked to the walls **20** and **36** and the tubular members **52** of the apparatuses **50** and **50***a* brought into sealing contact with the tube openings **26** and **42**, respectively.

While the apparatus and method of the present invention has been described with particular reference to the arrangement shown in the figures, i.e. , with the pivot point lying

between the end of the lever **70** distal tubular member **52**, it will be appreciated by those skilled in the art that the relative positions of tubular member **52** and arm member **98** can be reversed such that the pivot point would now be defined by the interconnection or locus of collar **60** and lever **70**, in which event to move tubular member **52** toward a respective tube opening and effect sealing between tubular member **52** and the tube opening, the force would be exerted on lever **70** in a direction opposite to that shown by arrow B. Accordingly, and with respect to FIG. **2**, in this latter described variation, tubular member **52** would be pivotally connected to lever **70** at generally the same location where mounting block **86** is connected to lever **70** while arm member **98** and mounting block **86** would be connected to lever **70** at generally the same point where tubular member **52** is shown as connected to lever **70**. In general, it will be appreciated by those skilled in the art that any arrangement of the tubular member and force transmitting means can be employed wherein the force transmitting means can be connected to the header such that a pivot point or axis can be established and such that a force acting around the pivot point or axis will serve to urge the tubular member **52** toward the tube opening to effect the seal between the tubular member **52** and the tube opening described above.

While sealing between the tubular member **52** and the tube openings, as described, is effected by engagement of an annular shoulder **59** formed between the nozzle **58** and tubular member **52**, it will be appreciated that the first end **54** of tubular member **52** can be tapered so as to fit into tube opening **12***a* until the O.D. of the taper on tubular member **52** is substantially the same as the I.D. of tube opening **12***a;* i.e., a peripheral seating surface would be formed internally of tube **12**. However, this method has the disadvantage that tubular member **52** can be become too tightly wedged in tube **12**, making disengagement difficult and/or worse, causing damage to tube **12** or to the interface between tube **12** and walls **18**, **34**.

The foregoing description illustrates selected embodiments of the present invention. In light thereof, variations and modifications will be suggested to one skilled in the art, all of which are in the spirit and purview of this invention.

What is claimed is:

1. An apparatus for use in cleaning the tubes of a heat exchanger of a type having at least one header, said header having spaced, first and second walls defining a manifold chamber therebetween, a plurality of tubes extending from said first wall and having ends cooperating with said first wall to define tube openings providing open communication between said tubes and said manifold chamber, each of said tube openings defining a peripheral seating surface, said second wall being provided with a plurality of bores, respective ones of said bores in said second wall being in register with respective ones of said tube openings in said first wall, said apparatus comprising:

a tubular member having a first end and a second end, said tubular member being dimensioned such that said first end of said tubular member can be received through at least one of said bores;

force transmitting means connected to said tubular member and operatively connectable to said second wall, said force transmitting means including a pivot point whereby a force exerted on said force transmitting means and acting around said pivot point urges said tubular member toward the seating surface of a tube opening in register with said bore through which said tubular member is received; and

means to effect a substantial seal between said tubular member and said seating surface.

2. The apparatus of claim **1**, including guide means operative to assist bringing said tubular member into register with said tube opening in register with said bore through which said tubular member is received.

3. The apparatus of claim **1**, including means for supplying a fluidized cleaning medium through said tubular member into said tube.

4. The apparatus of claim **1**, including means for conducting a fluidized cleaning medium through said tubular member out of said tube.

5. The apparatus of claim **1**, including a nozzle connected to said first end of said tubular member, said nozzle being smaller in diameter than said first end of said tubular member and being dimensioned so as to be received into said tube opening.

6. The apparatus of claim **5** wherein said nozzle and said first end of said tubular member cooperate to form an annular shoulder on said first end of said tubular member and said seating surface defines a planar annular surface in surrounding relationship in said tube opening, said annular shoulder being urged against said seating surface to form said seal.

7. The apparatus of claim **1** wherein said force transmitting means comprises:

a lever member having a first end, said lever member being pivotally connected to said tubular member distal said first end of said tubular member and distal said first end of said lever member; and

an arm member having one end releasably connectable to said second wall, said arm member being pivotally connected to said lever member distal said tubular member between said tubular member and said first end of said lever member, said pivot point being defined by the connection between said lever member and said arm member whereby when said arm member is connected to said second wall and said lever member is moved in a direction away from said first and second walls, said tubular member is moved toward said first and second walls.

8. The apparatus of claim **7** wherein said force connecting means includes adjusting means to permit adjusting the distance of said one end of said arm member from said lever member.

9. The apparatus of claim **8** wherein said force transmitting means comprises a collar attached to said second end of said tubular member, said lever member comprising a yoke portion having first and second tines, said collar being received between and pivotally connected to said first and second tines.

10. The apparatus of claim **9** wherein said force transmitting means further comprises a mounting block disposed between said first and second tines and pivotally connected thereto.

11. The apparatus of claim **10** wherein said mounting block includes a threaded bore extending therethrough and said arm member has a threaded second end, said threaded second end being received in said threaded bore in said mounting block.

12. The apparatus of claim **11** wherein said one end of said arm member comprises means for attaching to said second wall through a bore adjacent to said bore through which said tubular member is received.

13. The apparatus of claim **3** wherein said means for supplying a fluidized cleaning medium comprises means connected to said tubular member to supply a fluidized mixture of air and particulate solids.

14. A method for cleaning the tubes of a heat exchanger of a type having at least one header, said header having

spaced, first and second walls defining a first manifold chamber therebetween, a plurality of tubes extending from said first wall and having first ends cooperating with said first wall to define a first set of tube openings providing open communication between said tubes and said manifold chamber, each of said tube openings of said first set defining a peripheral seating surface, said second wall of said one header being provided with a plurality of bores, respective ones of said bores in said second wall of said one header being in register with respective ones of said tube openings of said first set, said method comprising:

introducing a first tubular member through one of said bores in said second wall of said one header;

bringing said first tubular member into register with one of said tube openings of said first set in register with said bore through which said first tubular member is received;

releasably connecting said first tubular member of said one header to said second wall to establish a first pivot point whereby a force exerted around the first pivot point urges said first tubular member toward said first and second walls of said one header;

exerting said force to effect a substantial seal between said first tubular member and said seating surface; and

introducing a fluidized cleaning medium through said first tubular member into said tube.

15. The method of claim **14**, including providing a lever assembly for effecting connection of said first tubular member to said second wall of said one header and for transmitting said force to said tubular member.

16. The method of claim **14** wherein said fluidized cleaning medium comprises a mixture of air and abrasive, particulate solids.

17. The method of claim **14** wherein said heat exchanger has a second header, said second header having spaced first and second walls defining a second manifold chamber therebetween, said tubes having second ends extending from said first wall of said second header and cooperating with said first wall of said second header to define a second set of tube openings providing open communication between said tubes and said second manifold chamber, each of said tube openings of said second set defining a peripheral seating surface, said second wall of said second header being provided with a plurality of bores, respective ones of said bores in said second wall of said second header being in register with respective ones of said tube openings of said second set, said method further comprising:

introducing a second tubular member through one of said bores in said second wall of said second header;

bringing said second tubular member into register with one of said tube openings of said second set in register with said bore through which said second tubular member is received and said tube opening of said first set, which is in register with said first tubular member;

releasably connecting said second tubular member to said second wall of said second header to establish a second pivot point whereby a force exerted around said second pivot point urges said second tubular member toward said first and second walls of said second header;

exerting said force to effect a substantial seal between said second tubular member and said seating surface of said tube opening of said second set; and

conducting said fluidized cleaning medium through said second tubular member out of said tube so as to prevent said cleaning medium from depositing in said second manifold chamber.

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